INFLUENCE OF ACIDIFICATION AND LIMING ON NEMATODES AND OLIGOCHAETES IN TWO CONIFEROUS FORESTS

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ВЛИЯНИЕ ПОДКИСЛЕНИЯ И ИЗВЕСТКОВАНИЯ НА НЕМАТОД И ОЛИГОХЕТ В ДВУХ ХВОЙНЫХ ЛЕСАХ

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Introduction

Acidification of forest soils due to atmospheric deposition has been considered as a serious problem in northern Europe /16/. Effects of experimental acidification on soil animals in coniferous forests have recently been studied by, e.g., /2, 7,1,6/. Application of lime counteracts soil acidification, and the effect of lime on soil animals has been examined in a number of studies by, e.g., /5,4,10,2,1,6/. According to these studies, different soil animal species respond very differently to acidification and liming. Furthermore, the effect on a given species may be different at different times after treatment.

The main objective of the present study was to examine the influence of experimental acidification and liming on the densities of nematodes, enchytraeids and lumbricids in two forests. The forest sites chosen had been treated with sulphuric acid and lime at different times before the samplings which made it possible to compare long- and short-term effects of acidification and liming on the soil animal populations.

Methods

Samplings were made at the experimental sites Fäxboda (60°08' N., 17°30'E, 40 m above M.S.L.) and Norrliden (64°21' N., 19°46' E, 260 m above M.S.L.) on October, 19, 1982 and September, 26, 1983, respectively.

Fäxboda is a 70-year-old stand of Norway spruce of the Oxalis-Myrtillus type. Annual mean air temperature is 5.5° and annual precipitation is 570mm. The soil is a podsol in a glacifluvial material dominated by fine sand. The humus form is a moder. The area was divided into 30x30 m plots with four replicates of each treatment (Table 1). For soil coring, 15 sample spots were randomly chosen within each treatment.

Table 1. Doses of 0,8% sulphuric acid (pH 1,8) and crushed limestone on the experimental sites

Site	Year	Control	Acid (kg H_2SO_4 ha^{-1})	Lime (kg ha^{-1})	Sources
Fäxboda	1980	-	200	2000	-
"	1981	-	200	-	-
"	1982	-	200	-	Present study
Norrliden	1971	-	50+50+50	5000	-
"	1972	-	50+50+50	-	-
"	1973	-	50+50+50	-	/14/
"	1974	-	150	-	-
"	1975	-	150	-	/14/
"	1976	-	150	-	/2/
"	1977-82	-	-	-	-
"	1983	-	-	-	Present study

Norrliden is a 30-year-old stand of Scots pine with a ground vegetation dominated by dwarf-shrubs like Vaccinium vitis-idaea and V.myrtillus. Annual mean temperature is 1.2° and annual precipitation is 595 mm. The soil type is till with a distinctly developed iron podsol /9/. The humus form is a mor. The area is divided into 30x30 m plots with three replicates of each treatment. Treatments are given in Table 1. Five sample spots were chosen randomly from each plot for soil coring.

Nematodes, enchytraeids and lumbricids were sampled from each sample spot, the sample units being 4.5 cm^2 (area) x 15 cm (depth), 15.9 cm^2x10cm, and 400 cm^2 x 10 cm, respectively. Nematodes and enchytraeids were extracted from the soil in Baermann funnels, and lumbricids by a modified Tullgren funnel technique. Statistical analysis was made by one-way analysis of variance followed by pairwise tests using the least significant difference (LSD) method.

Results

At both sites, the experimental acidification had reduced the pH by 0.4 units in the upper part of the soil (Table 2). Liming had a more pronounced effect on pH at Norrliden than at Fäxboda, where the dose was lower and the application was made only two years before sampling.

Table 2. Average soil pH_{H_2O}. After B.Popović (unpubl.) and /15/

Soil horizon	Fäxboda (1982) Acid	Control	Lime	Norrliden (1978) Acid	Control	Lime
A_0	4.0	4.4	5.5	3.8	4.2	6.3
A_1	3.9	4.3	4.5	4.0	4.4	6.7
A_2	-	-	-	4.2	4.5	5.3
B	4.3	4.6	4.6	4.5	5.0	5.3

The effects of the treatments on the soil animal densities are summarized in Fig. 1. At Fäxboda, the acidification caused significant reductions ($p < 0.05$) in the total number of nematodes and enchytraeids in comparison with untreated and limed plots, and liming increased the number of lumbricids in comparison with untreated and acidified plots. At Norrliden, acidification had reduced the number of lumbricids in comparison with liming. The number of enchytraeids was significantly higher in the acidified than in the untreated and limed plots. No significant differences between treat-

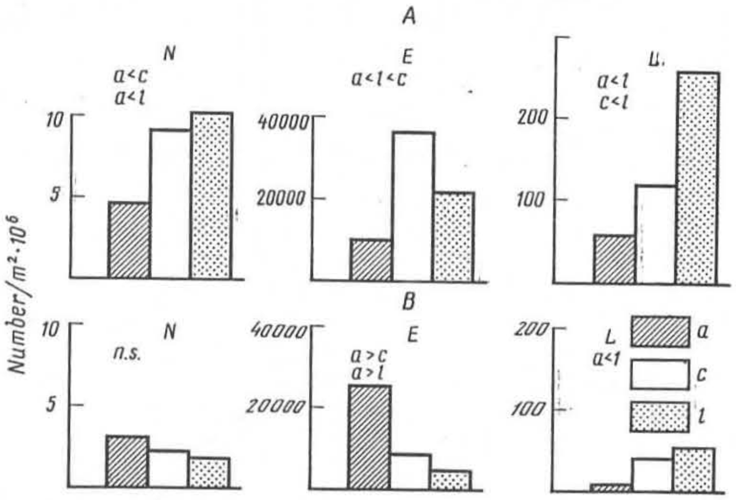

Fig. 1. Mean densities of soil animals at (A) Fäxboda, sampled 2 years after liming and in the same year as the last acidification, and (B) Norrliden, sampled 12 years after liming and 6 years after last acidification (see Table 1)

Treatments are: a - sulphuric acid, c - control and l - crushed limestone. Significant differencies ($p < 0,05$) are indicated, n.s. - not significant; N - Nematoda, E - Enchytraeidae, L - Lumbricidae ments could be detected at Norrliden for the nematodes. At both sites, Cognettia sphagnetorum (Vejd.) and Dendrobaena octaedra (Sav.) dominated the enchytraeid and lumbricid numbers, respectively. Most nematodes were bacterial feeders.

Discussion

The marked reduction of enchytraeid numbers in the acidified plots at Fäxboda is in agreement with earlier studies at Norrliden, where [/14/ and /2/] were found much lower numbers in acidified than in untreated plots. These samplings have in common that they were performed in the same year that the plots were treated with 0.8% sulphuric acid, often only 3-5 months after the application.

The present sampling at Norrliden shows that the enchytraeids were more numerous in the acidified plots than in the untreated plots. As this sampling was made six years after the last acidification, the enchytraeid populations should have had time to recover from possible toxic effect of the acid. The positive effect of the long-term acidification was due to a population increase in Cognettia sphagnetorum, which made up about 99% of the enchytraeid numbers. The results are in agreement with /7/ and /1/, where it was found that this species is positively influenced by weak acidification and reaches high population levels at about pH 3.7-4.0. We conclude that the low populations earlier estimated at Norrliden /14,2/ and recently at Fäxboda are due to toxic concentrations of acid, as 3-5 months seem to be too short a period for the populations to recover. Also the nematode and lumbricid numbers at Fäxboda might have been affected by the high concentration of acid.

Liming affected the number of lumbricids positively and that of enchytraeids negatively at both sites. This is in agreement with literature data. Positive effects of liming on lumbricid numbers have been reported by, for example, /5,13,4,10/. Negative effects of liming on enchytraeids have been reported by /14,2,7,1,11/. In all these cases, the dominant enchytraeid was C.sphagnetorum, which seems to be negatively affected by high pH. The reason for this reaction is not clear, but some factor associated with pH should be important.

Nematodes usually seem to increase in numbers directly after liming /5, 8,12/, but after some years with lime the nematode density mostly will decrease /5,3,12/. Our data do not diverge from this pattern. However, different feeding categories may react differently in relation to acidification and liming. This will be presented in a forthcoming paper.

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